

Unit 4: The Skeletal System

Pleasant Valley High School
Anatomy and Physiology

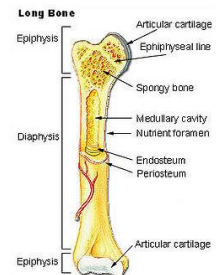
- Bones are very much alive, contrary to their artistic display
- The organs of the skeletal system
- Provide points of attachment for muscle
- Protect and support soft tissue
- House blood producing cells
- Store inorganic salts
- Contain passageways for blood vessels and nerves
- A variety of tissue
 - Bone tissue
 - Cartilage
 - Dense connective tissue
 - Blood
 - Nervous tissue

7.1 Introduction

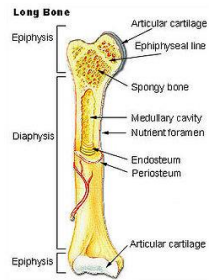
- Epiphysis – expanded portion of a bone located at the ends, articulates a joint with another bone
- Articular cartilage – located near the epiphysis, a layer of hyaline cartilage that forms the barrier between the bones
- Diaphysis – the shaft of the bone, located between two epiphyses
- Periosteum – outer coating of the bone, tough and vascular coat made of fibrous tissue, helps to repair damaged bone tissue
- Processes- bony projections, provide a site for a tendon and ligament to attach

7.2 Bone Structure

- Compact Bone – the wall of the diaphysis is made of densely compacted bone, sometimes called cortical bone
- The epiphysis is made of spongy bone, as is the internal structure of the diaphysis
 - Spongy bone is a series of interlinking bone web
 - Designed to decrease the weight of the bone, but provide support by increasing surface area
 - Most highly developed and intricate in areas of high impact and stress



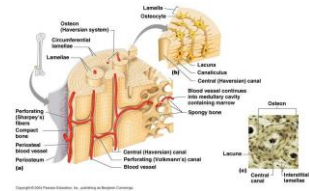
- Medullary Cavity – compact bone in the diaphysis forms a semirigid tube with a hollow chamber
- Endosteum – a thin layer of cells lining the medullary cavity
- Marrow – specialized soft tissue that fills the medullary cavity



- Osteocytes (bone cells) are located in bony chambers (lacunae) and form concentric circles around *central canals* (Haversian Canals) which travel vertically. They are connected by horizontal *perforating canals* (Volkmann's Canals) which contain large blood vessels and nerves which branch through the spongy bone to provide blood.

- This entire structure is called an Osteon

Microscopic Structure



1. List 5 major components of long bone.
2. How do compact and spongy bone differ in structure?
3. Describe the microscopic structure of compact bone.

Check Your Recall

- Parts of the skeletal system form during the first few weeks of prenatal development

- Bones form in one of two ways:
 - Intramembranous bones originate between sheetlike layers of connective tissues
 - Endochondrial bones begin as masses of cartilage that eventually turn into bone

7.3 Bone Development and Growth

- During development, membrane like layers of connective tissue appear at the site of future bones
 - In particular, the bones of the skull
- Some of those tissue cells enlarge and differentiate into *osteoblasts*, bone making cells
 - Osteoblasts deposit a bone matrix around them and spongy bone tissue forms in all directions around the osteoblasts
 - The remaining connective tissue give rise to the periosteum
 - The eventual product is the formation of osteocytes...AKA bones

Intramembranous Bones

- Most bones in the body are endochondrial
 - All long bones in the body are endochondrial
- Form from masses of hyaline cartilage that are in the shapes of bones
 - Bones grow rapidly for a while and then the pattern changes once a mass occurs
 - In the center of the diaphysis, the cartilage breaks down and disappears
 - The periosteum forms from surrounding tissue
 - Blood vessels and osteoblasts invade the forming periosteum and develop spongy bone in an area called the *primary ossification center*
 - Osteoblasts form a thin layer around the primary ossification center
 - The *secondary ossification center* develops in the epiphysis and makes spongy bone in all directions
 - The spongy bone is deposited in the diaphysis and epiphysis and a band of cartilage called the *epiphyseal plate*, or metaphysis, remains between the two centers

Endochondrial Bones

- The cells that make up the epiphyseal plate are constantly undergoing mitosis and forming new cells
- As matrix grows around these cells, the bone lengthens
- Calcium salts accumulate and calcifies the bone matrix, the cells begin to die
- *Osteoclasts*, large and multinucleated cells, break down the calcified matrix. These cells originate in bone marrow
- The osteoclasts promote new growth again and the bone continues to grow.
- ***If the epiphyseal plate is damaged, the bone growth will cease or grow abnormally...the growth plate***

- Bone cancers are unique in that osteoblasts which have abnormally mutated destroy existing bone
- In most other cancers, mutated cells mass produce and cause tumors

Bone Cancers

- Support and Protection
- *Hemopoiesis* – the formation of blood cells
 - Hemoglobin – red, oxygen carrying pigment that gives red blood and bone marrow its color
 - Red marrow - forms RBC, WBC, platelets and turns into yellow marrow
- Storage of inorganic salts
 - Calcium Phosphate, Magnesium, Sodium, Potassium, Carbonate ions
 - Know the effects of calcium concentrations on bone formation (Figure 7.7)
 - Calcium is important to muscle contraction, nerve impulse, and blood clotting

7.4 Bone Function

- Axial Skeleton – bones and cartilage that support the organs of the head, neck, and trunk
 - Skull
 - Composed of the cranium and facial bones
 - Hyoid Bone
 - Located between the lower jaw and larynx, supports the tongue and is an attachment for muscles used in swallowing
 - Vertebral Column
 - Many vertebrae separated by *intervertebral discs*, at the distal end fused vertebrae form the **sacrum**, the tailbone is the **coccyx**
 - Thoracic Cage
 - Protects the organs of the thoracic cavity, twelve pairs of ribs, sternum

7.5 Skeletal Organization

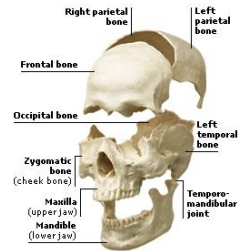
- Appendicular Skeleton – bones of the upper and lower limbs and the bones that anchor them to the axial skeleton
 - Pectoral Girdle
 - Scapula and clavicle on each side
 - Upper Limbs
 - Humerus, radius, ulna, carpals, metacarpals, and phalanges
 - Pelvic Girdle
 - Coxae (hip bones), sacrum, coccyx, pelvis
 - Lower Limbs
 - Femur, tibia, fibula, patella, tarsals, metatarsals, phalanges

- Table 7.1 lists all of the bones in the adult human body
- Table 7.2 Lists terms that are associated with skeletal anatomy
- You will be quizzed on the following:
 - Bones of the Axial Skeleton
 - Bones of the Appendicular Skeleton
 - Bones of the Skull
 - Bones of the Vertebral Column

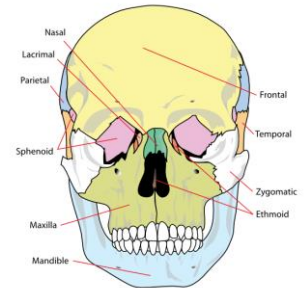
Study the Bones

7.6 The Skull

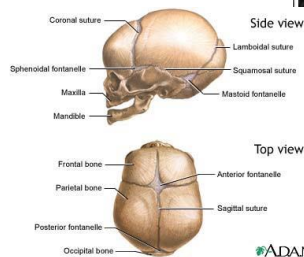
- Cranium – encloses and protects the brain
 - Contain *sinuses*, air filled cavities intended to reduce the weight of the head
 - 8 major bones in the cranium
 - Know the bones and their functions



- Facial Skelton – thirteen immovable bones and a movable lower jawbone (Mandible)
 - Maxilla – the upper jaw
 - Palatine Bones – L shaped bones behind the maxilla, form the palate
 - Zygomatic Bones – form the prominence of the cheeks
 - Lacrimal Bones – thin structure in the medial wall of each orbit
 - Nasal Bones – long, thin, and rectangular, fused at the midline
 - Vomer Bone – along the midline, within the nasal cavity
 - Inferior nasal conchae – fragile, scroll shaped bones attached to the lateral walls of the nasal cavity
 - Mandible – horizontal, horseshoe shaped bone, lower jaw

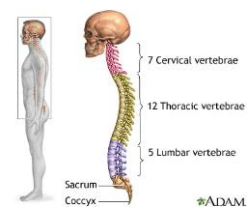


- Infantile Skull – at birth, the skull is incomplete
 - Fibrous membranes connect the cranial bones – *fontanels*
 - Often called *soft spots*
 - They permit movement and allow for some adjustment to the skull shape
 - Small face with a prominent forehead and large orbits
 - Skull bones are thin and flexible and are less easily fractured than adult bones



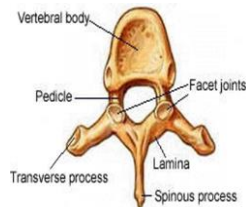
7.7 The Vertebral Column

- Bone structures called vertebrae are separated by fibrocartilage called intervertebral discs and are connected to one another with ligaments



- Each level of vertebrae have specific characteristics, but some are uniform amongst all levels
- Pedicles** – project posteriorly from each body
- Laminae** – plates that arise from the pedicles and fuse in the back
- Spinous process** – the fusion of laminae
- Vertebral arch** – the combination of the three aforementioned parts
- Vertebral foramen** – the hole in which the spinal cord passes
- Transverse process** – between the pedicle and lamina
- Inferior articulating processes** – projections from the bottom of the vertebrae, connect to the facet joints as seen to the right
- Intervertebral foramina** – notches that align to form and opening for spinal nerves, located below the pedicles

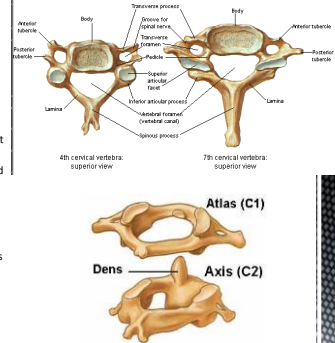
Anatomy of a Vertebrae



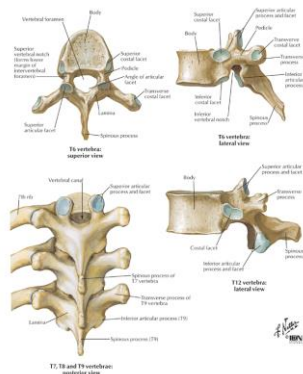
Cervical Vertebrae - the bony axis of the neck

- Transverse process of the cervical vertebrae are unique due to transverse foramen allowing blood flow to the brain
- The spinous process of C2-C5 are forked, *bifid*
- 2 cervical vertebrae are of special interest
- Atlas – C1, supports the head, on its superior surface are two kidney shaped facets that articulate the occipital condyles
- Axis – C2, has a toothlike *dens* (odontoid process) that projects upwards and lies in the ring of the atlas, as the head turns the atlas pivots around the dens

Cervical Vertebrae [C4 and C7] Superior Views

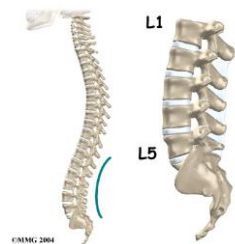


- Thoracic Vertebrae** –
- Larger than cervical vertebrae
- Long, pointed spinous process that slopes downward
- Facets on the side of the body which articulates with a rib
- Beginning with T3 and moving inferiorly, the vertebrae increase in size
- They are adapted to support body weight



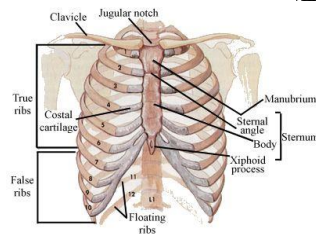
Lumbar vertebrae – located in the small of the back

- Two specialized lumbar structures
- Sacrum**
 - Triangular structure made of 5 fused vertebrae, forms the base of the vertebral column
 - The spinous processes form a ridge of *tubercles*, along side of them are *dorsal sacral foramina* which nerves and blood vessels pass
- Coccyx**
 - The lowest point in the vertebral column
 - Usually composed of 4 fused vertebrae
 - Known as the tailbone



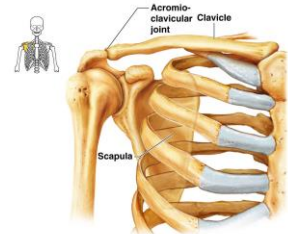
- Includes ribs, thoracic vertebrae, sternum, and costal cartilages
- Support the shoulder girdle and upper limbs, protect the viscera, and play a vital role in breathing
- 2 major components
 - Ribs
 - Usual number is 12, one pair attached to each of the thoracic vertebrae
 - The first 7 are *true ribs* meaning that they join the sternum via costal cartilage
 - The remaining 5 pairs are *false ribs* because they do not reach the sternum directly
 - The last 2 or 3 pairs are called floating ribs because they do not have cartilage
 - Know the anatomy of a rib bone
 - Sternum
 - Breastbone
 - Three parts:
 - Manubrium – upper section
 - Body – middle
 - Xiphoid process – lower projection

7.8 The Thoracic Cage



- Composed of 4 parts: two clavicles and two scapulae
- Supports the upper limbs and is an attachment for the muscles that move them
 - Clavicles –
 - collarbones
 - Slender, rod-like bones
 - Brace the scapulae helping to hold the shoulders in place
 - Scapulae –
 - Shoulder blades
 - Located on either side of the upper back
 - The spine divides the posterior of the two bones
 - Glenoid fossa – a depression that articulates the humerus
 - Two processes:
 - Acromion process – forms the tip of the shoulder
 - Coracoid process – curves anteriorly and inferiorly to the clavicle

7.9 The Pectoral Girdle



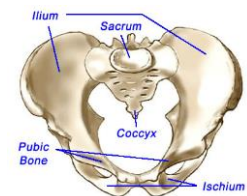
(a) Articulated right shoulder (pectoral) girdle showing the relationship to bones of the thorax and sternum
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- Humerus
 - Upper Arm bone, connects to glenoid fossa
- Radius
 - Located on the thumb side of the forearm
- Ulna
 - Longer than the radius, pinky side of the forearm
- Wrist and Hand
 - Wrist is made of 8 carpals
 - Hand is made of 5 metacarpals
 - Fingers are 15 phalanges
 - 3 per finger making up the knuckles at their connection points

7.10 The Upper Limb

- Supports the trunk of the body
- Provides attachments for the lower limbs
- Protects the urinary bladder, distal end of the large intestine, and the internal reproductive organs
- The female pelvis is wider in all diameters
- The male coccyx points inward

7.11 The Pelvic Girdle



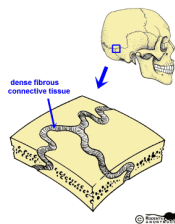
- Femur
 - Thigh bone
 - Longest and largest in the body
- Tibia
 - shin bone, larger of the two lower leg bones, located on the medial side
- Fibula
 - Long bone located on the lateral side of the tibia
- Patella
 - Knee cap
- Ankle and Foot
 - Tarsus – 7 tarsal bones
 - Talus – the only tarsal bone that moves independently
 - 5 metatarsals
 - 15 phalanges
 - 3 in each toe

7.12 The Lower Limb

7.13 Joint Types

Fibrous Joints

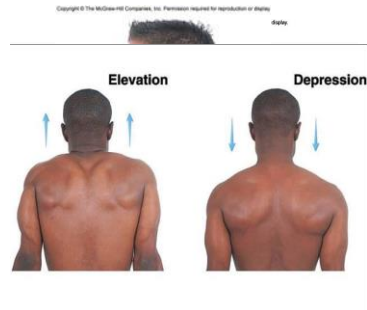
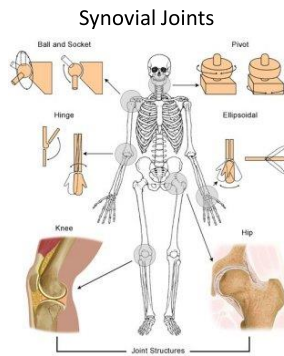
- Lie between bones that are in close contact with one another
- A thin layer of connective tissue *suture* the bones
- No movements take place at these joints
 - With the exception of the joint between the distal ends of the fibula and tibia, very limited movement



- When hyaline or fibrocartilage connects bones
- Very slight flexibility
- Usually in two directions
 - Either :
 - Forward and back
 - Side to side



- Allow free movement
- *Menisci* – shock absorbing pads of fibrocartilage
- *Bursae* – fluid filled sacs
- Six types of Synovial Joints
 - Ball and Socket – ball shaped head articulates with the cup shaped cavity, shoulder
 - Condyloid - oval shaped condyle fits into an elliptical cavity, metacarpals and phalanges
 - Gliding – nearly flat but slightly curved, wrists and hands
 - Hinge – convex surface fits into a concave surface, elbow or joints within the phalanges
 - Pivot – cylindrical surface rotates within a ring of bone and cartilage, proximal ends of the radius and ulna
 - Saddle – forms between bones whose articulating surfaces have both concave and convex regions, carpals and metacarpals of the thumb



Types of Joint Movement